A Standard Smart Transducer Interface - IEEE 1451

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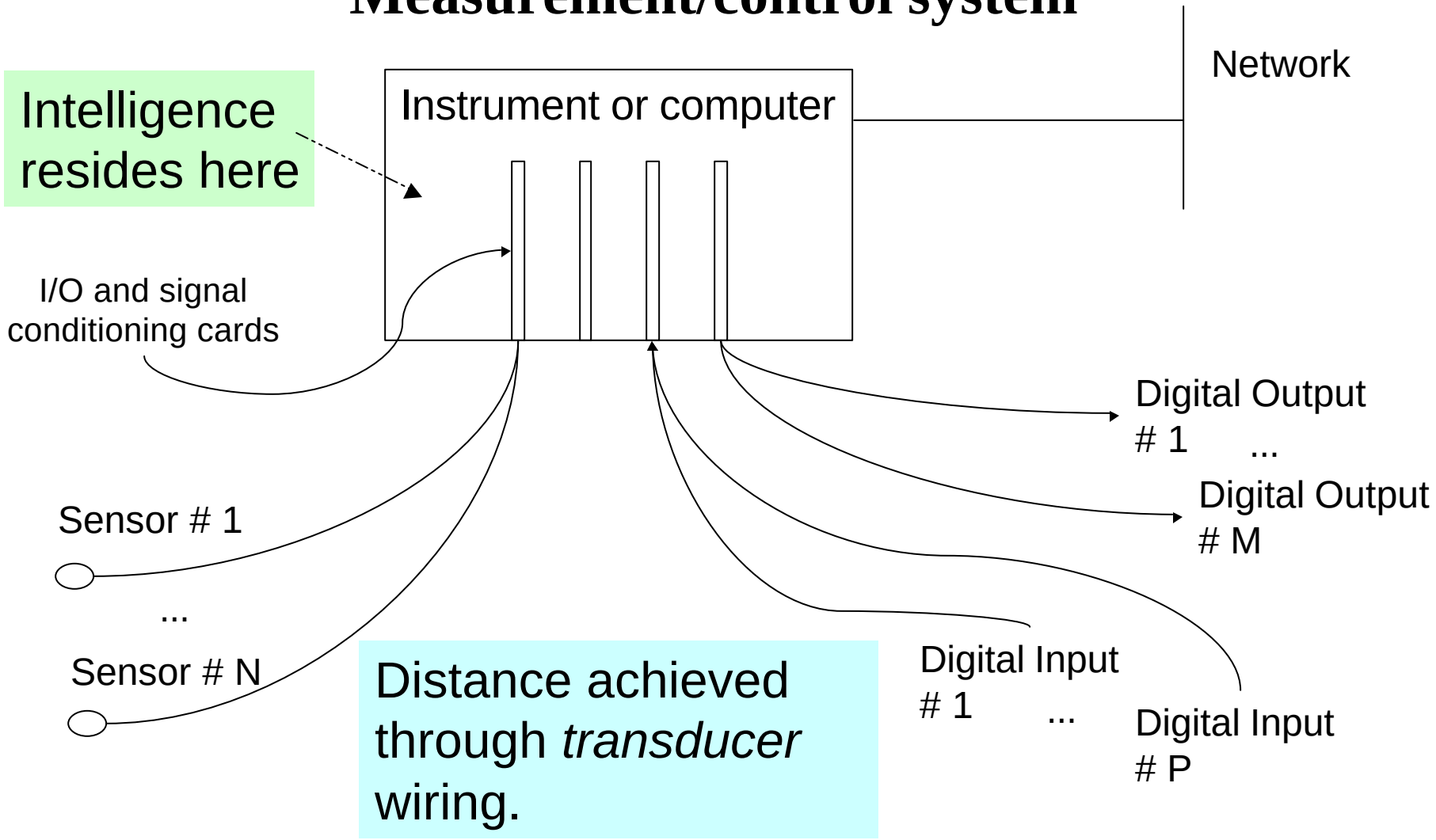
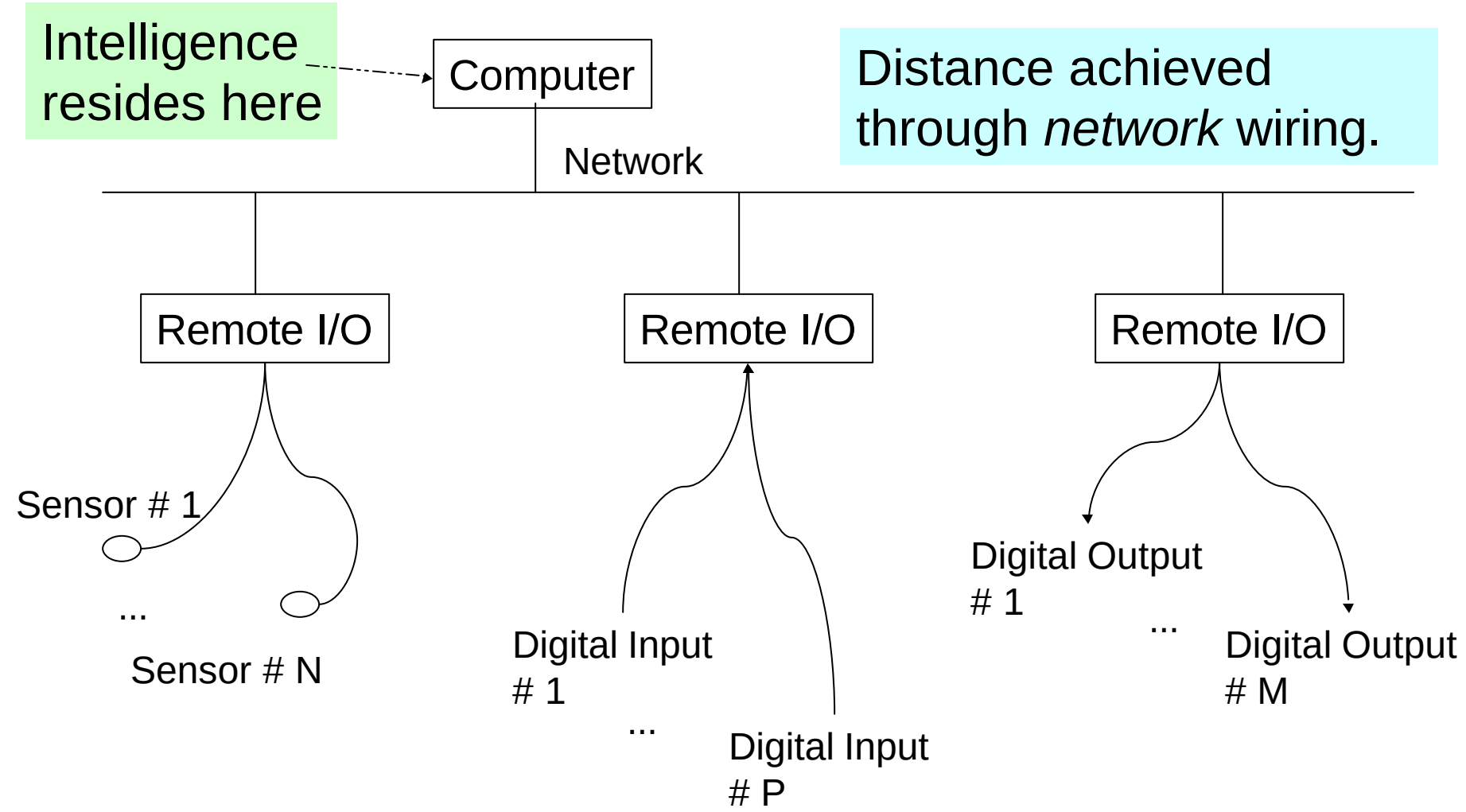
Agenda

- **Measurement and control systems**
- **Smart transducers**
- **Introduction to IEEE 1451**
- **Benefits of the 1451 standard**
- **Contacts for further information**

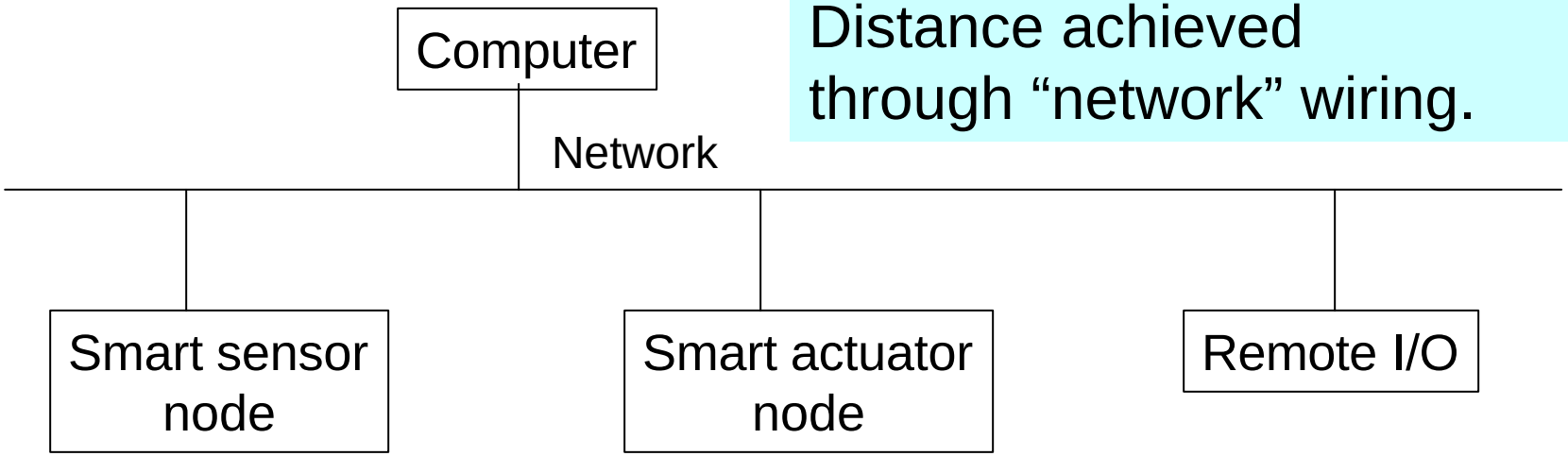
Measurement/control system



Distributed measurement/control system



Distributed smart sensor/actuator system



Distance achieved through “network” wiring.

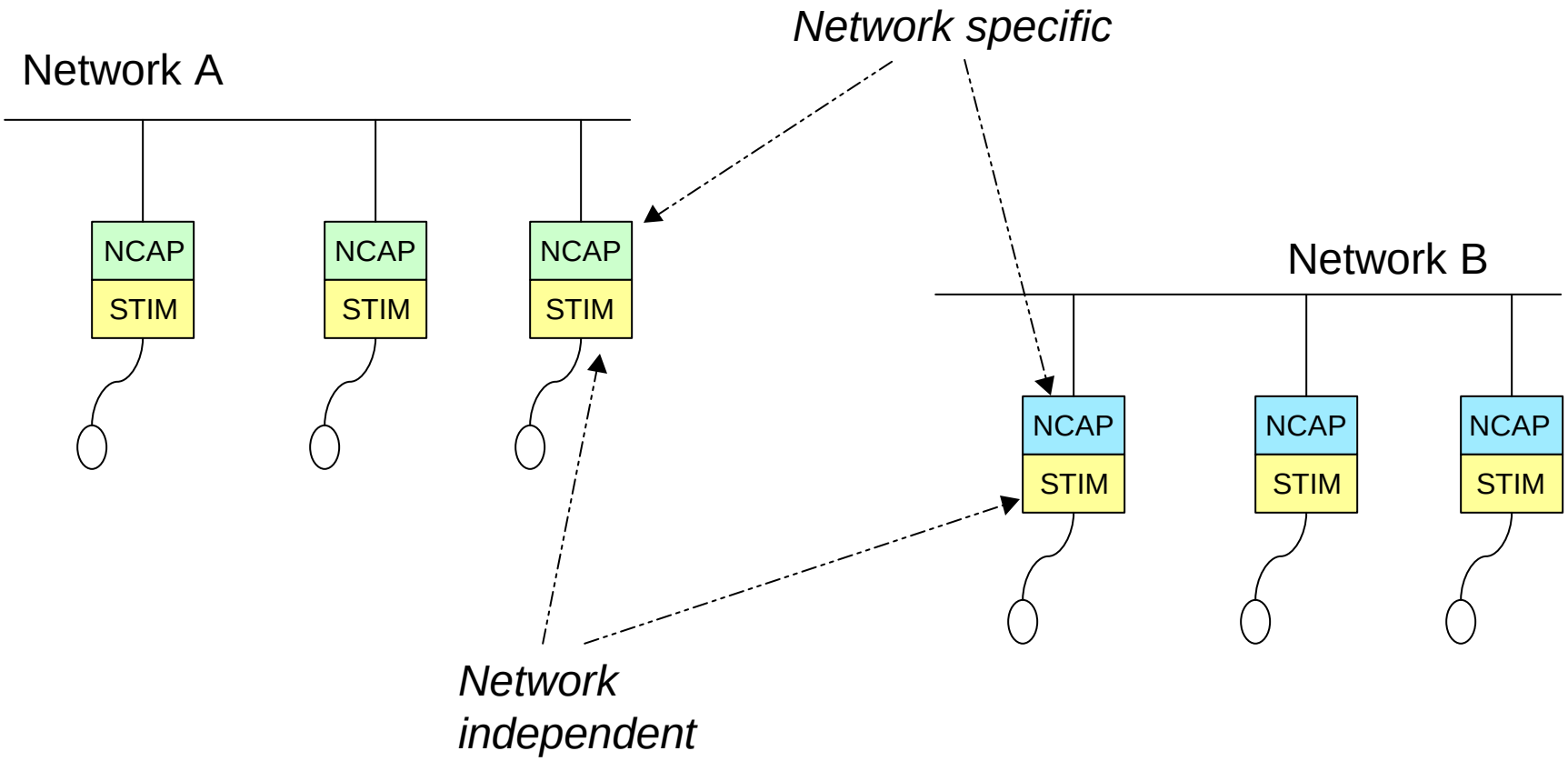
Intelligence is distributed; role of computer changes.

However:
smart nodes are still network and transducer specific with vendor specific data and control models.

Main goals for 1451

- Develop network independent and vendor independent transducer interfaces.
- Allow transducers to be replaced/moved with minimum effort.
- Eliminate error prone, manual system configuration steps.
- Support a general transducer data, control, timing, configuration and calibration model.
- Develop Transducer Electronic Data Sheets that remain together with the transducer during normal operation.

Network independent transducers



Desirable functions in sensors that provide "smarts"

- Self-identification, self-diagnostic.
- Output digital data in standard engineering units.
- "Time aware" for timestamping and correlation
- Software functions, e.g.:
  - signal processing and data logging
  - measurements derived from multi-channels
- Conforming to a standard data and control protocol

What standards are being developed ?

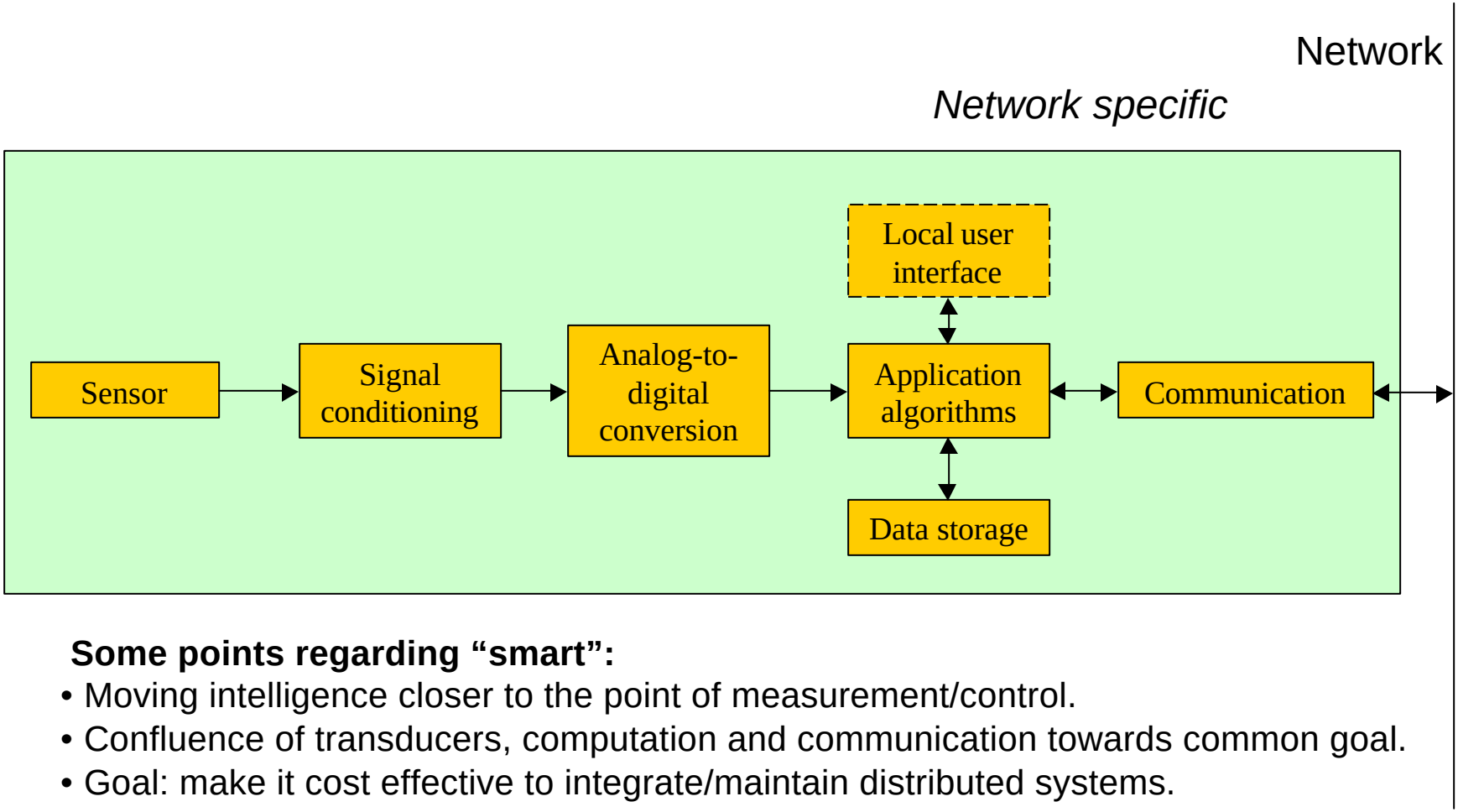
- **IEEE Std 1451.1-1999,** Network Capable Application Processor (NCAP) Information Model for smart transducers -- Published standard.

- **IEEE Std 1451.2-1997,** Transducer to Microprocessor Communication Protocols and Transducer Electronic Data Sheet (TEDS) Formats -- Published standard.

- **IEEE P1451.3,** Digital Communication and Transducer Electronic Data Sheet (TEDS) Formats for Distributed Multidrop Systems -- Being developed

- **IEEE P1451.4,** Mixed-mode Communication Protocols and Transducer Electronic Data Sheet (TEDS) Formats --- Being developed

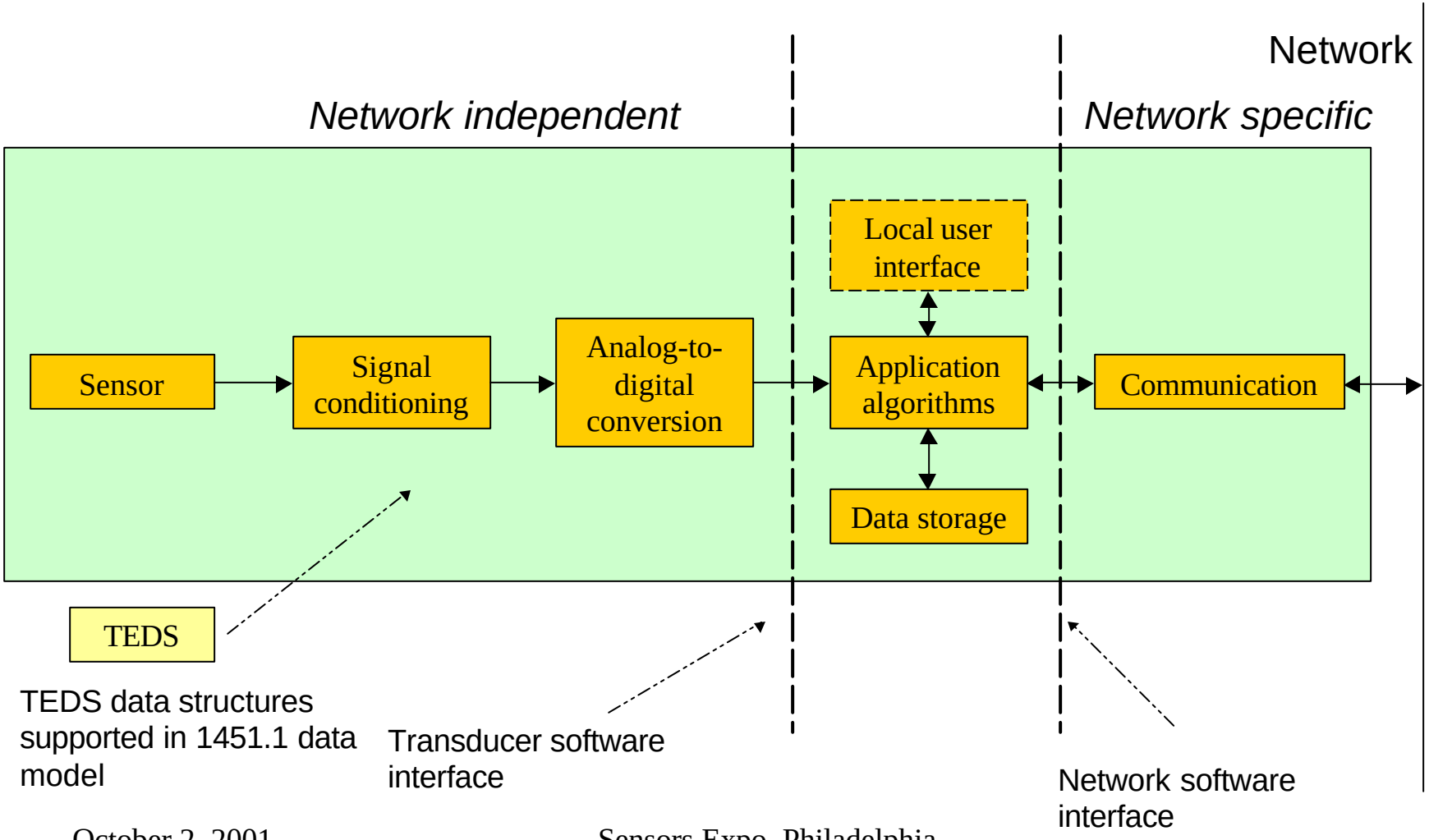
A general model of a smart sensor



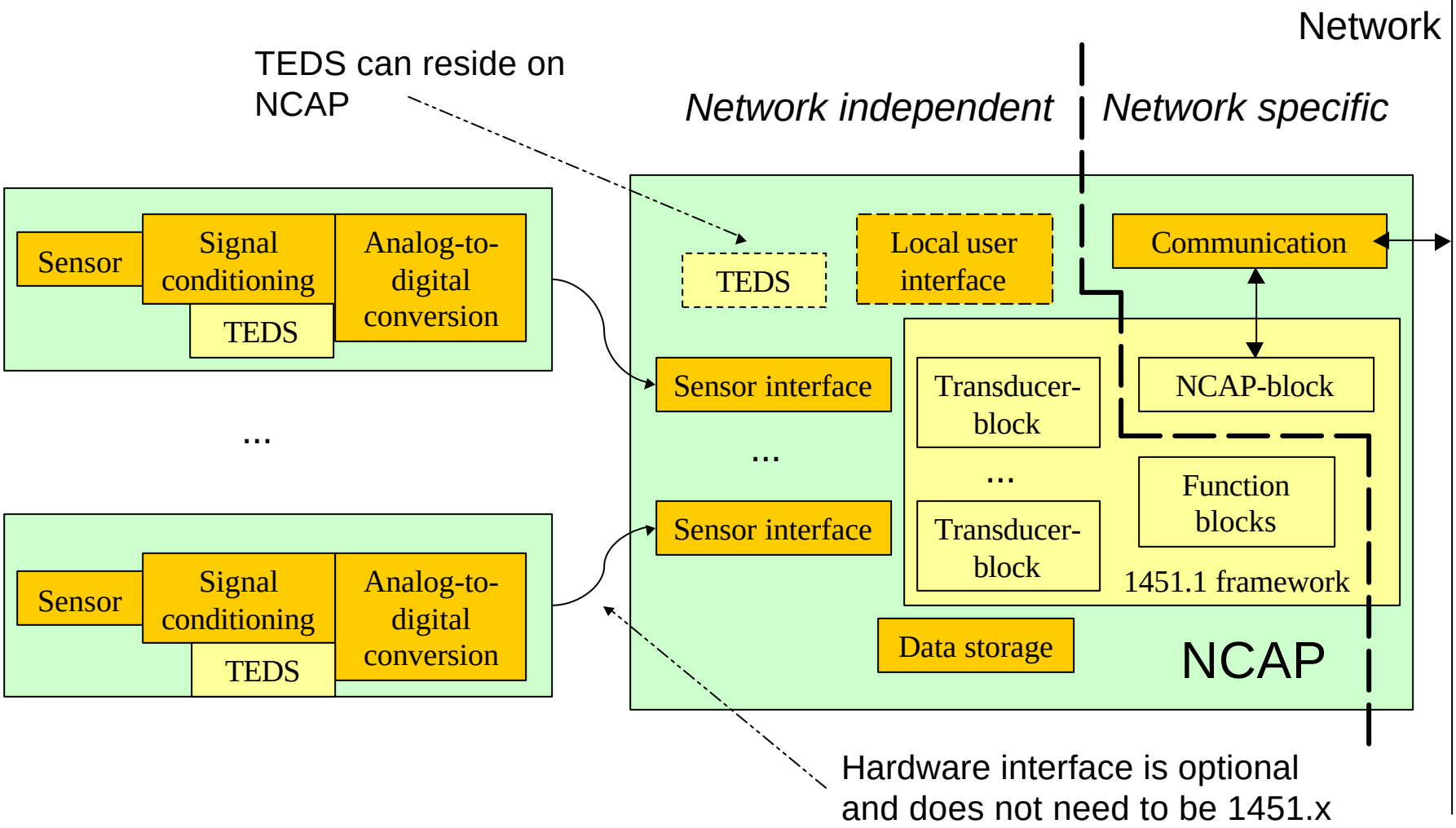
Some points regarding "smart":

- Moving intelligence closer to the point of measurement/control.
- Confluence of transducers, computation and communication towards common goal.
- Goal: make it cost effective to integrate/maintain distributed systems.

1451.1 partition of general model



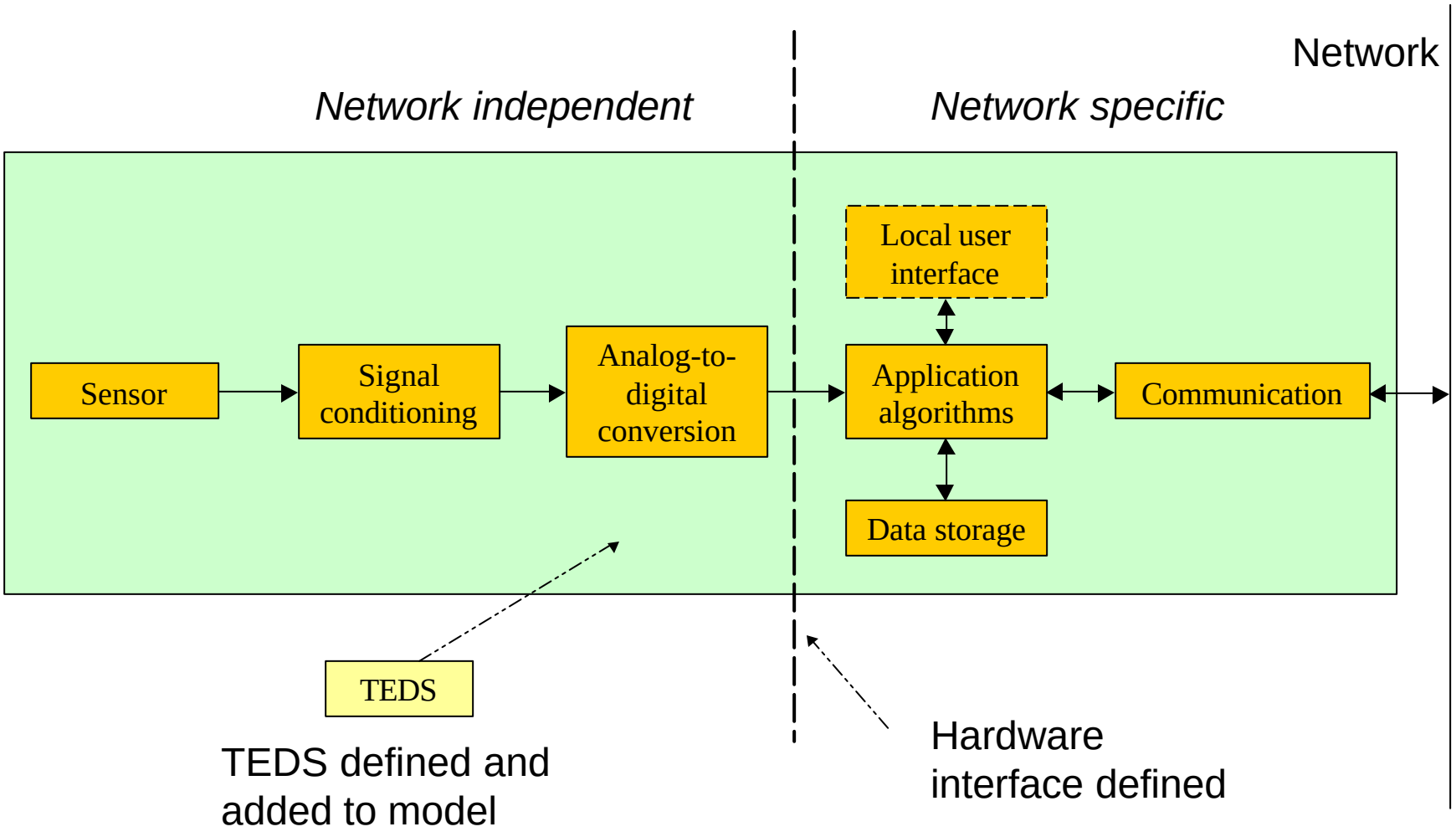
1451.1 resulting implementation



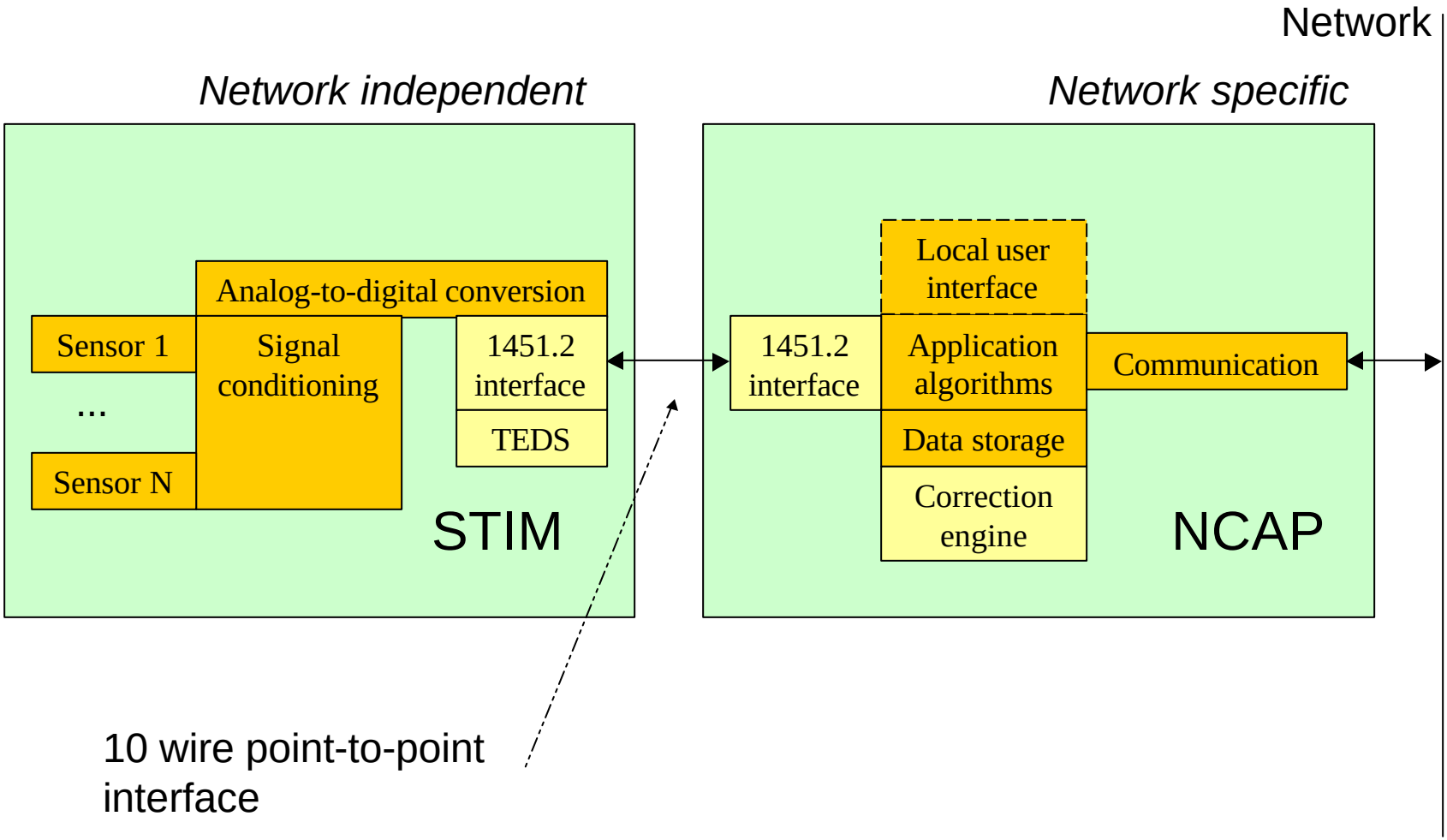
IEEE Std 1451.1-1999 distinguishing features

- Common object model can be used with multiple networking protocols.
- Uniform models for key functions needed in smart transducers including physical parametric data, application functionality and communication.
- Framework is defined to help create smart transducers.

1451.2 partition of general model



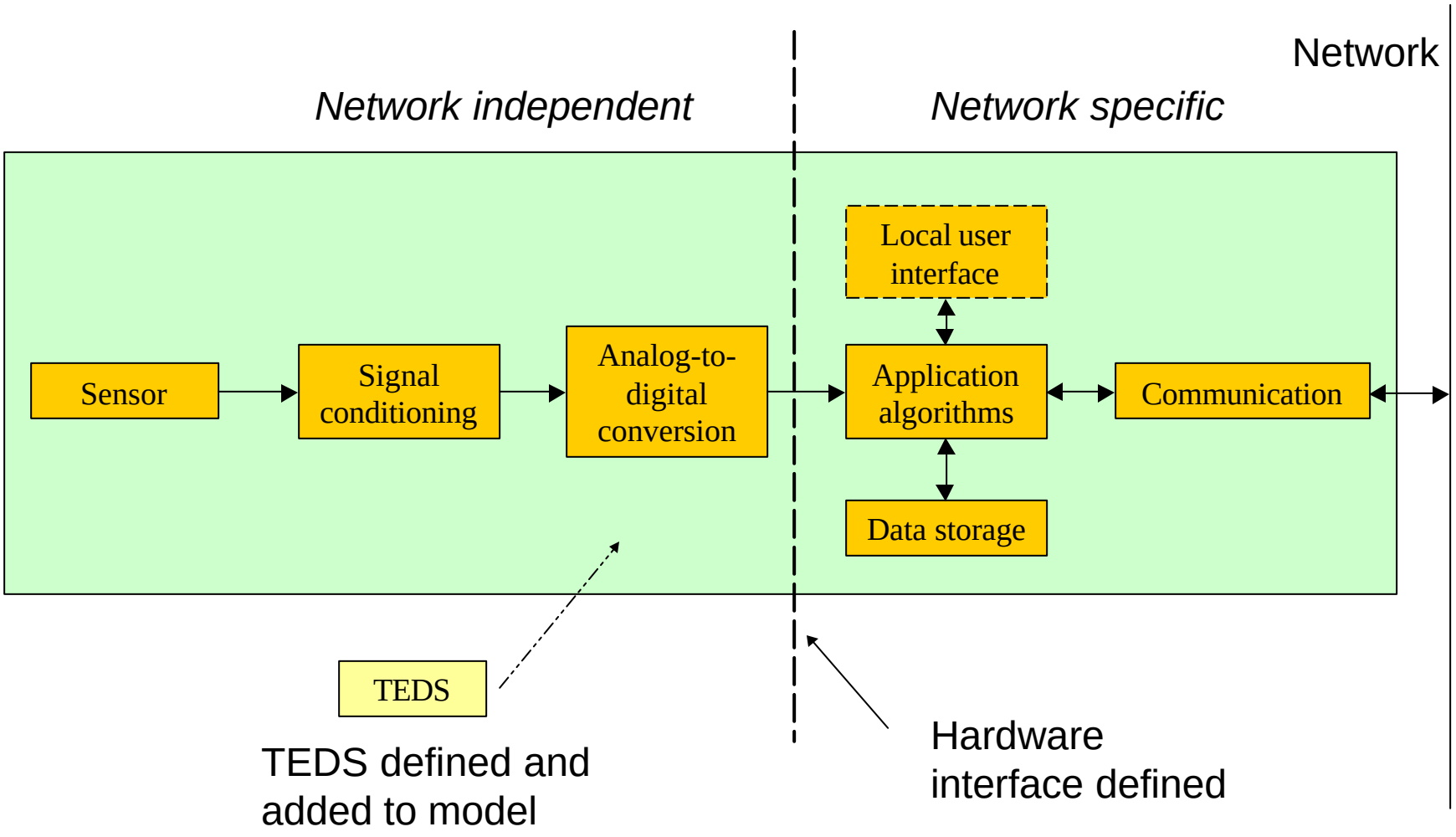
1451.2 resulting implementation



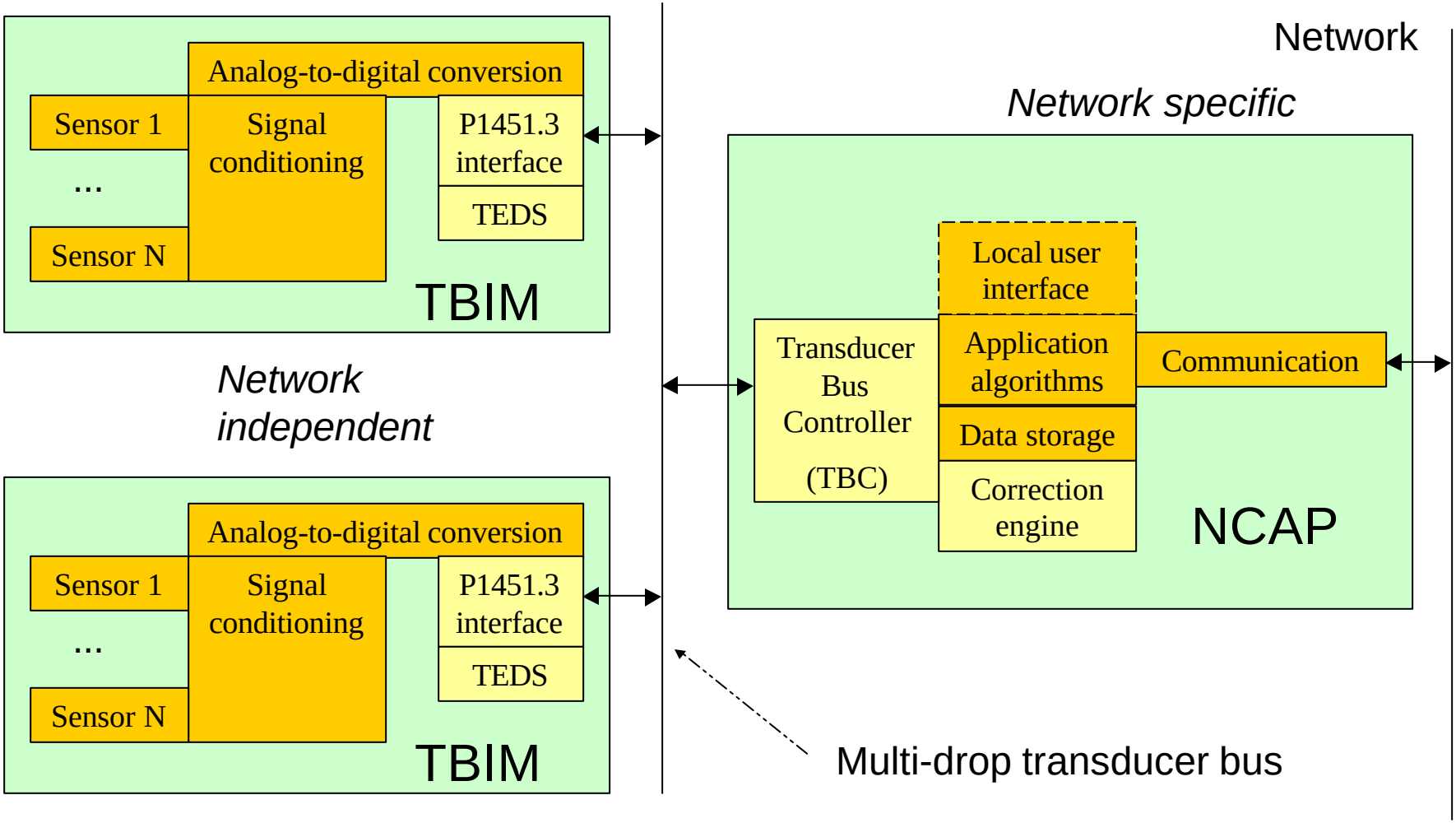
IEEE Std 1451.2-1997 distinguishing features

- Extensible Transducer Electronic Data Sheet (TEDS)
- General calibration/correction model for transducers.
- Physical units representation based on SI units.
- Triggering and control model defines how channels are accessed.
- All channels may be triggered simultaneously, timing parameters are used to indicate channel differences.
- Models for different kinds of sensors
- Powerful concept of correction engine and flexible location of correction engine.

P1451.3 partition of general model



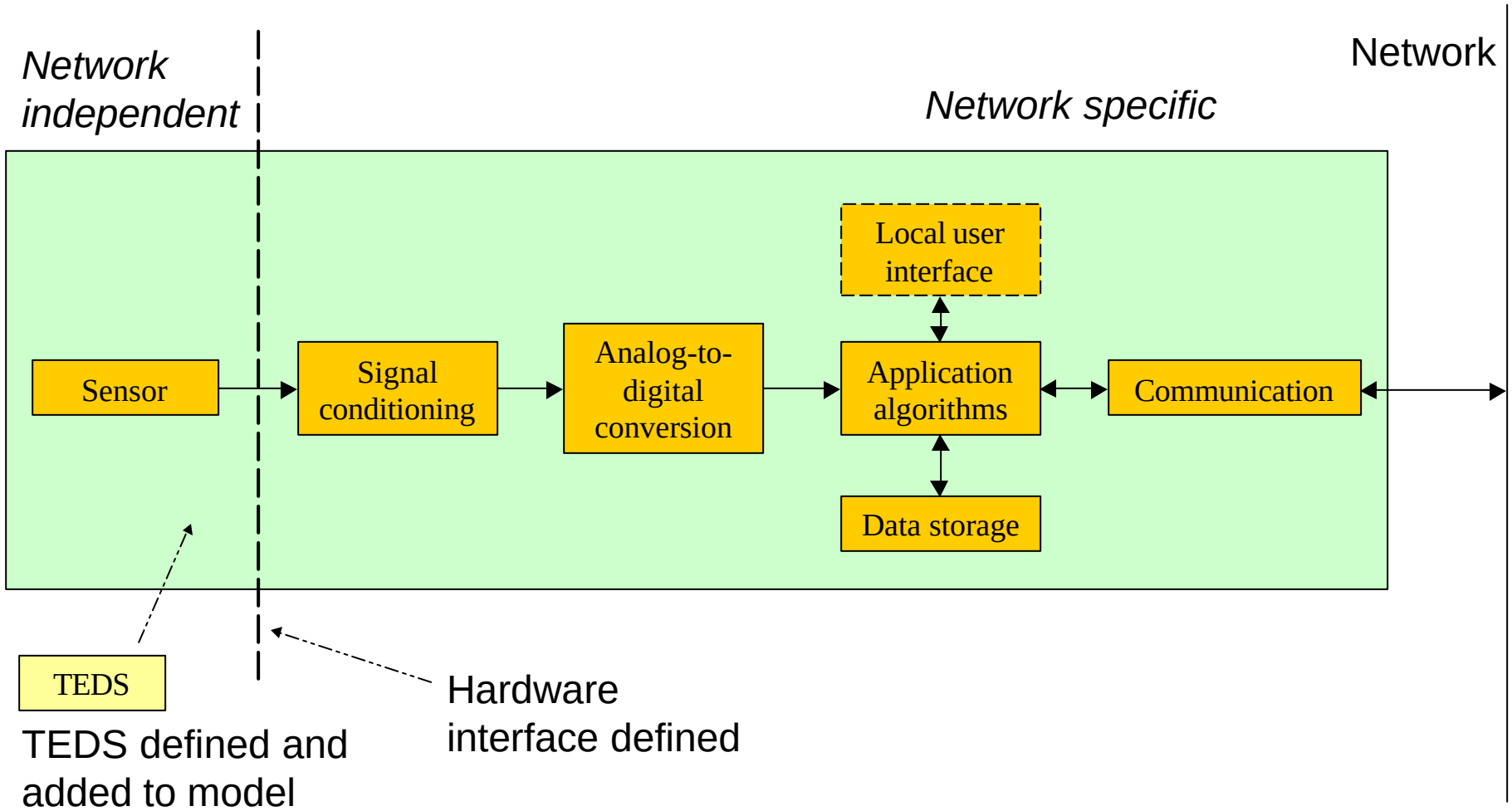
P1451.3 resulting implementation



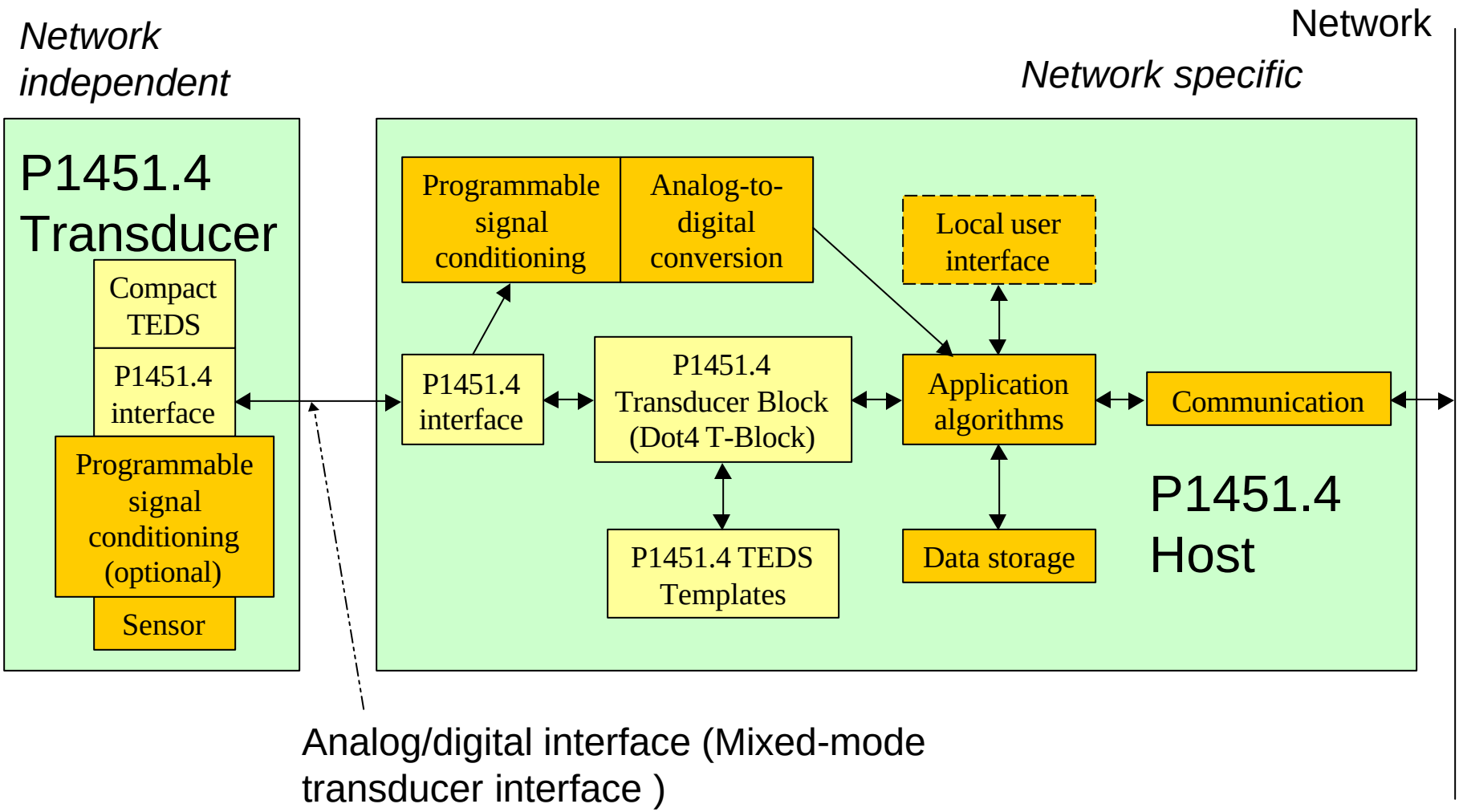
IEEE P1451.3 distinguishing features

- Multi-drop, high speed interface permits continuous streaming of data to host.
- Similar to 1451.2 in terms of TEDS, calibration/correction model, triggering/control model, data models.
- TEDS enhanced with new features such as XML format, more actuator models.
- Synchronized measurements at the Transducer Bus Interface Module (TBIM).

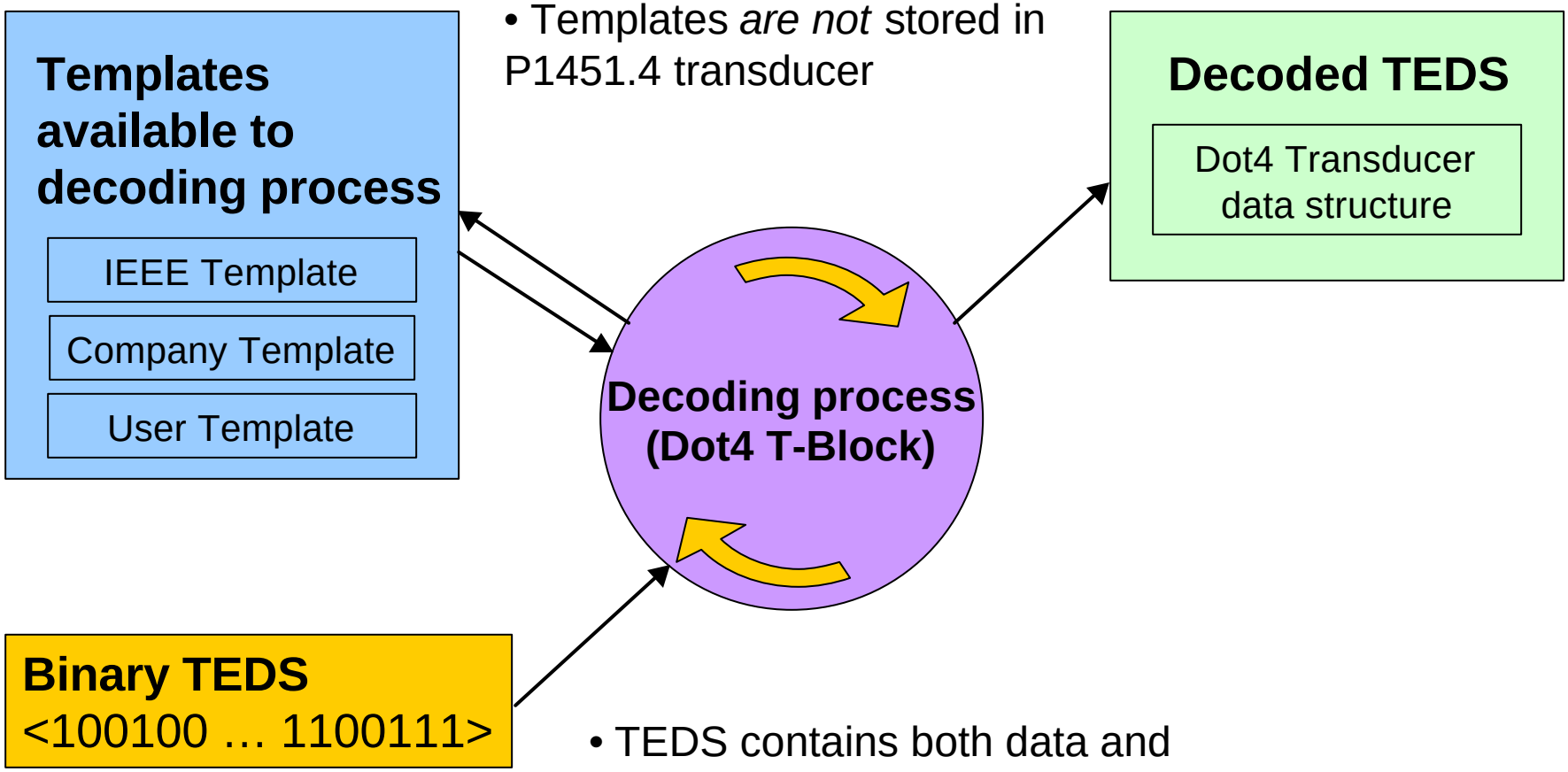
P1451.4 partition of general model



P1451.4 resulting implementation



Decoding a P1451.4 TEDS

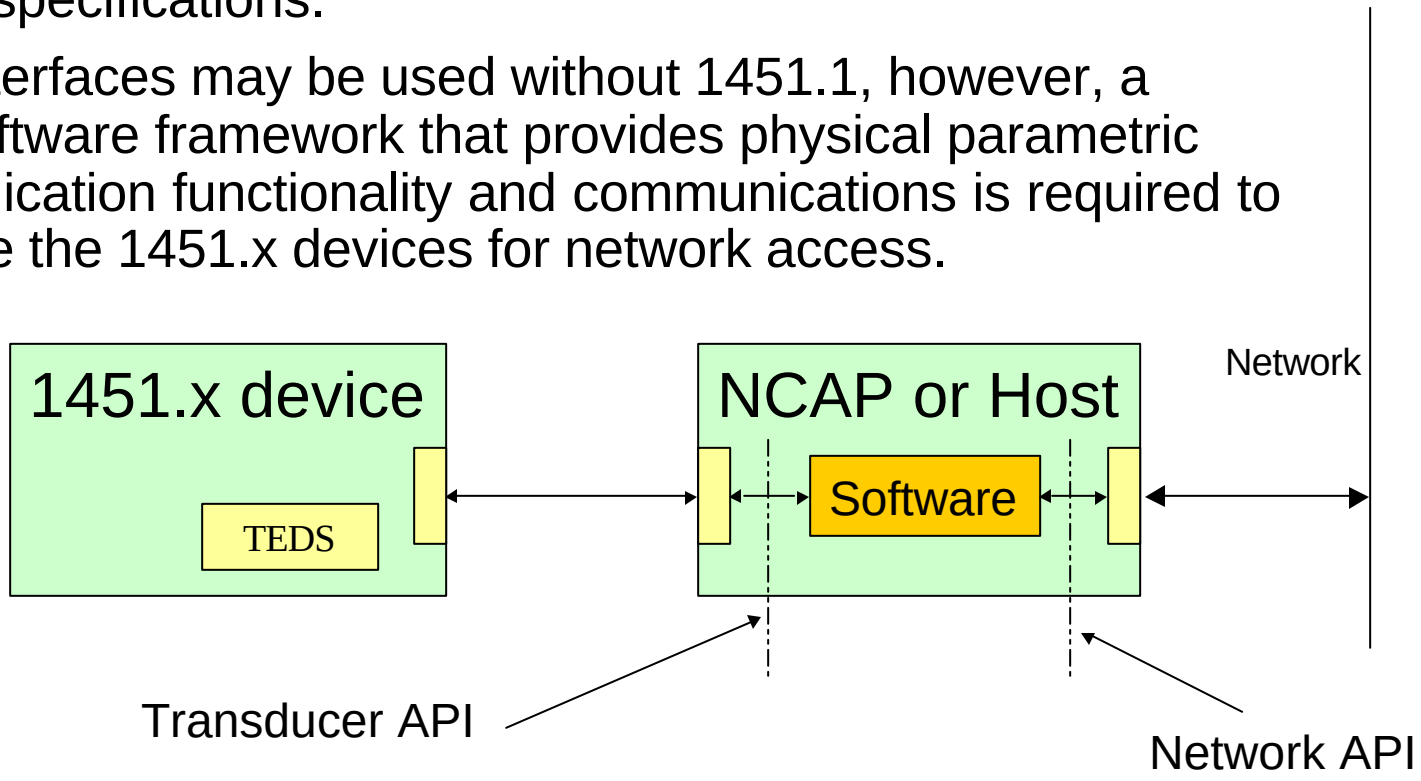


IEEE P1451.4 distinguishing features

- Compact TEDS is very small, sized in *bits* (as small as 67 bits, typically 256 bits), *not bytes*.
- TEDS plus Templates permits extensible self-identification of key transducer parameters.
- Mixed mode interface:
  - Digital interface to read and write the TEDS or control the transducer. For example: adjust pre-amplifier gain, change filter setting, start self-test.
  - Analog interface to make measurements in normal manner.

Relationship between 1451 standards

- The 1451 standards are being developed to work together, however they also stand on their own.
- 1451.1 may be used without any of the other 1451.x hardware interface specifications.
- 1451.x interfaces may be used without 1451.1, however, a similar software framework that provides physical parametric data, application functionality and communications is required to fully utilize the 1451.x devices for network access.



Benefits from 1451

Sensor manufacturers

- Multiple products may be developed just by changing the TEDS.
- Standard physical interfaces
- Standard calibration specification

System integrators

- Self-documenting hardware and software
- Systems that are easier to maintain
- Rapid transducer replacement
- Mechanism to store installation details

Benefits from 1451 (continued)

Application software programmers

- Standard transducer model for control and data
- Same model for accessing a wide variety of measurements
- “Hooks” for synchronization, exceptions, simultaneous sampling
- Support for multiple languages

End users

- Sensors that are easier to use; “you just plug them in”.
- Analysis software that can automatically provide:
  - physical units
  - readings with significant digits
  - transducer specifications
  - installation details such as physical location and ID of transducer

For more information

1451 standard	Contact	Telephone	Email
IEEE P1451	Kang Lee	301-975-6604	kang.lee@nist.gov
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